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INFORMATION CIRCULAR 39

Pennsylvania Geological Survey
Fourth Series

GEOLOGIC INTERPRETATION of AEROMAGNETIC MAPS

EASTON & RIEGELSVILLE QUADRANGLES

by

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1960

FOREWORD

Southeastern Pennsylvania is an area of extremely varied and complex geology with a long history of mineral production. The list of mineral commodities which this area has yielded at various times is considerable, but iron-ore stands out as the most prominent. Scores of iron mines and furnaces have operated in this area in the past 200 years. With a record of production dating back to Pre-Revolutionary War years, the mine at Cornwall is the oldest continuously operating iron mine in the United States. The recent development of the large and magnificent Grace Mine at Morgantown is living testimony to the fact that Pennsylvania's metallic mining record is not simply a story of the past. Through modern methods of exploration and research, new mineral resources remain to be found.

The Bureau of Topographic and Geologic Survey of the Department of Internal Affairs is pleased to have participated and cooperated with the United States Geological Survey in carrying out an aeromagnetic survey of Southeastern Pennsylvania. This modern exploration technique is particularly well suited to the geologic conditions and to the potential mineral resources of the area; it is an extremely efficient method of acquiring geologic data for a large region. The results of the aeromagnetic survey are being published by the United States Geological Survey as a series of aeromagnetic contour maps.

We are pleased to present this publication as a service to the Commonwealth of Pennsylvania. It is hoped that this interpretation and discussion of the aeromagnetic maps will serve as a stimulus for further research and development.

Genevieve Blatt

Genevieve Blatt, Secretary
Department of Internal Affairs

GEOLOGIC INTERPRETATION OF AEROMAGNETIC MAPS EASTON AND RIEGELSVILLE QUADRANGLES

General Statement

The magnetic contour maps being discussed in this series of publications are the result of a cooperative project of the United States Geological Survey and the Pennsylvania Geological Survey, Department of Internal Affairs. About 5,000 square miles of southeastern Pennsylvania have been covered in this survey, the results of which are being published as individual 7 1/2-minute quadrangle maps.

This information circular is one of a series intended as a preliminary explanation of the interrelation of distinctive magnetic features with geological conditions in each quadrangle. In many instances unusual magnetic patterns can be explained by geological features which have been mapped and studied in the past. It is hoped that the map viewer will not only be aided by such correlation of data, but that this publication may stimulate exploration and research in those areas where there is at present no known or satisfactory geological explanation for some of the magnetic features which appear on the magnetic contour map. Such exploration and research could directly or indirectly lead to discovery and development of new mineral deposits and would greatly further the basic knowledge of the geology of Pennsylvania.

The magnetic contour lines on the map are lines connecting points of equal magnetic intensity. The shape, position and spacing of the magnetic lines are due to the combined effects of the earth itself, which is a huge magnet, and to the local variations in the magnetism of the rocks underlying any given area. If only the earth as a large, uniform body were responsible for the magnetic lines, they would be essentially straight and simple. It is the local geology, however, which imparts complexities to the patterns of the magnetic lines. Such complexities or variations from a simple pattern are called anomalies.

Local magnetic effects vary from place to place because the magnetic properties of the respective rocks are not alike or because differences in rock structure from place to place change the magnetism measured at the surface. Rocks which have different kinds or different relative amounts of minerals, particularly iron-bearing minerals, have unlike magnetic properties. In general, the more iron minerals present, the stronger the magnetic effect. The iron oxide mineral, magnetite, has a strong magnetic effect even when present in small quantities; when present in large amounts, magnetite is of economic interest as a possible iron ore.

If in a given area the rocks have been folded or faulted by internal earth forces, the resulting variation in position of the different rocks will be indicated by variation in magnetic readings from place to place. Thus, structural complexities as well as mineral variations may be revealed by the magnetic data. Of particular interest are those magnetic variations or anomalies which are circular or tend to enclose a given area; the implication in such cases is that there is a specific, localized causative factor more or less pin-pointed by such a pattern.

The aeromagnetic survey of southeastern Pennsylvania was carried out with the use of an airborne magnetometer, an instrument towed by a plane. The plane covered the area by flying back and forth along straight, parallel flight lines spaced a quarter mile apart. An attempt was made to maintain an elevation of 500 feet, above the ground so as to eliminate magnetic changes due solely to terrain changes. An airborne magnetic survey has the advantage of eliminating very minor magnetic features on the ground, thus permitting a better evaluation of larger and deeper magnetic phenomena. It should be borne in mind that the instruments which have measured the magnetic effects in these studies are very sensitive and capable of detecting small changes. Proper evaluation of these changes is necessary to distinguish those situations which offer possibilities for economic mineral development from those cases where the information yielded is of more academic interest.

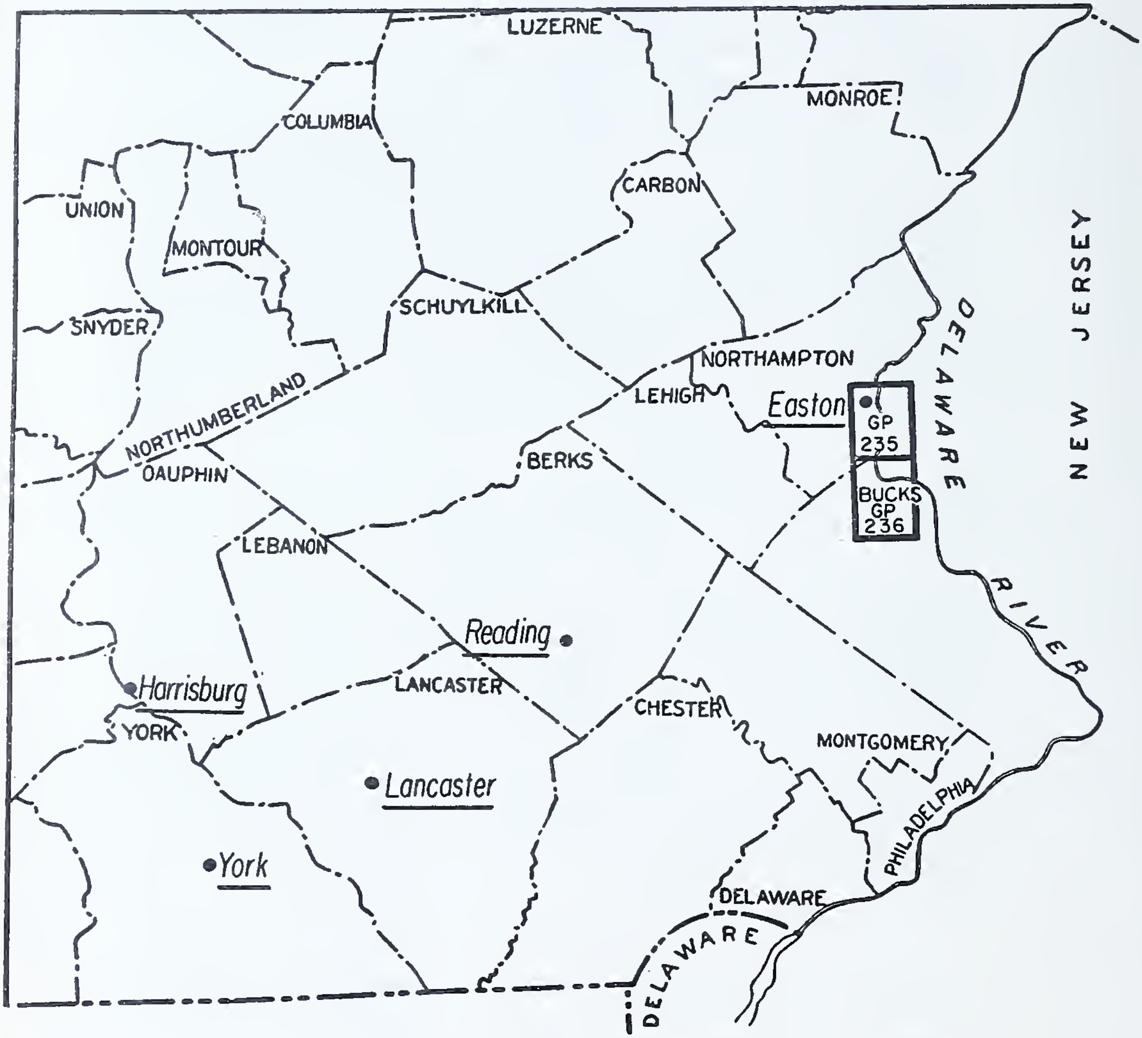
Only the western half of the Easton quadrangle, that portion west of the Delaware River, has been covered by this aeromagnetic survey. The magnetic patterns exhibit a marked distinction between the areas of crystalline rocks and those of sedimentary rocks. The crystalline areas exhibit numerous anomalies of various size, shape and orientation. The sedimentary belts,as at the city of Easton and at the northern third of the quadrangle, show relatively low, uniform magnetic fields.

An elongate, northeasterly-trending positive magnetic anomaly, just north of the city of Easton, is underlain by a belt of gneiss and serpentinized Franklin marble. Both of these rock units contain conspicuous quantities of disseminated magnetite as well as other iron silicate minerals. The anomaly has an amplitude of 1000 gammas but this is an amplitude accentuated by marked contrast with adjacent lithologies and structures; no iron concentration of mining proportion is indicated at this location.

A number of anomalies occur over the crystallines in the southern half of the area mapped. One is centered over Morgan Hill, two miles south of Easton, another occurs southeast of Fairview School, and a third is over Elephant Rock. Each of the anomalies in the gneissic area is located over a topographic high and in turn, the topographic high appears to be related to the local composition of the rock. Various authors have ascribed different names to the gneisses of the area, but in each case the rock under the anomaly is darker and richer in iron minerals, including magnetite, than the rocks in the rest of the area. Course disseminated magnetite can be observed in the field; at Morgan Hill, where the anomaly has an amplitude of 800 gammas, an ill-fated attempt was once made to mine the material.

The anomalies appear to be the composite result of the disseminated magnetite and the topography. There does not appear to be any indication of a magnetite concentration which has economic mining possibilities.

INDEX OF AEROMAGNETIC MAPS DISCUSSED IN THIS PUBLICATION



GP 235 Easton quadrangle
GP 236 Riegelsville quadrangle

Bibliography

Bayley, W. S. (1941), *Precambrian Geology and Mineral Resources of the Delaware Water Gap and Easton Quadrangles, New Jersey and Pennsylvania*; U. S. Geol. Survey Bull. 920.

Miller, B. L., et al (1939), *Geology and Geography of Northampton County, Pennsylvania*; Pa. Geol. Survey, 4th series, Bull. C 48.

Riegelsville Quadrangle
U. S. Geological Survey Aeromagnetic Map G. P. 236

Only the portion of the Riegelsville quadrangle west of the Delaware River has been covered by this aeromagnetic survey. There is a distinct correlation between the magnetic patterns and the type of underlying rock. In the southern part of the quadrangle, the magnetic contours are simple and widely spaced; that is an area underlain by a thick sequence of Triassic sandstones and shales. In the Coffeetown area, in the northern part of the quadrangle, a large negative anomaly is developed over a northeast-trending belt of Cambrian limestones. The rest of the quadrangle exhibits a number of anomalies of various sizes, shapes and orientations; this involves an area underlain by a complex of crystalline rocks.

A positive magnetic anomaly occurs over Rattlesnake Hill near Durham Furnace in Durham Township. The anomaly is less than a mile long and has an amplitude of nearly 300 gammas. Rattlesnake Hill and nearby Mine Hill were the site of a number of small iron mines which supplied magnetite and hematite ore to Durham Furnace intermittently from 1700 to 1908. Bayley (1941) reports the ore occurred as a number of lenses and pods within the gneissic country-rock. Dimensions varied greatly from orebody to orebody, and even within individual orebodies; maximum reported width was 50 feet, length 500 feet, and height 40 feet. The ore contained about 50 percent iron content and quartz was the chief gangue; some barite is also present but it is believed to have been introduced in Triassic time. The general geological setting and nature of the ore are similar to the larger and better known iron operations in the crystalline rocks of New Jersey. The anomaly over Rattlesnake Hill indicates some magnetite remains but the small size and amplitude suggest that the iron concentration is too small in size and too low in grade to warrant economic development. It is noteworthy that Mine Hill, which was the site of considerable mining at the time of Rattlesnake Hill activity, shows no related anomaly. This is attributable to the predominance of non-magnetic hematite, rather than magnetite, at Mine Hill.

A positive anomaly is centered over Monroe in Durham Township. It trends northeasterly, has a length of over a mile and an amplitude of over 150 gammas. The anomaly occurs where Triassic limestone conglomerate is in fault contact with Precambrian gneisses, Cambrian sandstones, and a sliver of Cambrian limestone. The limestones present offer an ideal host rock for mineralizing solutions, and it is noteworthy that this is an area where barite mineralization of Triassic age is reported. The anomaly suggests a mineralized zone which could be either a magnetite-bearing zone in underlying gneiss or else magnetite mineralization along the fault. If the anomaly were larger and more intense, the situation would be interesting and worth of further research. The fault zone may have served as a channel for mineralizing solutions related to the Triassic diabase intrusion which formed just a couple of'miles to the south.

A small anomaly lies southwest of the Monroe anomaly described above and is apparently of the same origin. Being less than a half mile in diameter with an amplitude of only 100 gammas, it has no economic potential.

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